AD-A067 888 SWEDLOW INC GARDEN GROVE CALIF F/G 19/4
MANUFACTURING METHODS AND TECHNOLOGY (MM/T) PROJECT TO ESTABLIS--ETC(U)
JAN 79 R DOERR DAAB07-77-C-0476
UNCLASSIFIED SI-ER-915-6 NL

1 OF 1
AD
A067888

END
DATE
FILMED
6--79
DDC

LEVEL III

(13) B.S.

SI ER-915-6

SIXTH QUARTERLY REPORT

AD A067888

DDC FILE COPY

MANUFACTURING METHODS AND TECHNOLOGY PROJECT TO ESTABLISH PRODUCTION TECHNIQUES TO MANUFACTURE RIGID ARMOR FOR RADAR ANTENNA HARDENING

REPORT PERIOD

1 SEPTEMBER 1978 TO 30 NOVEMBER 1978

TECHNICAL SUPPORT DIRECTORATE
UNITED STATES ARMY ELECTRONICS
RESEARCH AND DEVELOPMENT COMMAND
FORT MONMOUTH, NEW JERSEY

PREPARED UNDER CONTRACT NO. DAAB07-77-C-0476

A057 963
A051 695

PREPARED BY

SWEDLOW, INC.

12122 Western Avenue, Garden Grove, California 92645

79 04 25 096

NOTICES

This project has been accomplished as part of the US Army Manufacturing Methods and Technology Program which has as its objective the timely establishment of manufacturing processes, techniques or equipment to insure the efficient production of current or future defense programs.

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER 14 SI-ER-915-6

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER 9

4. TITLE (and Subtitle) 6

MANUFACTURING METHODS AND TECHNOLOGY (MM&T) PROJECT TO ESTABLISH PRODUCTION TECHNIQUES TO MANUFACTURE RIGID ARMOR FOR RADAR ANTENNA HARDENING.

A057 982

5. TYPE OF REPORT & PERIOD COVERED

Sixth Quarterly Report. no. 6,
1 Sep[redacted] 30 Nov 1978,

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)

10 R. Doerr

8. CONTRACT OR GRANT NUMBER(s)

Contract No.
15 DAAB07-77-C-0476

9. PERFORMING ORGANIZATION NAME AND ADDRESS

Swedlow, Inc.
12122 Western Avenue
Garden Grove, Ca 92645

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

12 23p.

11. CONTROLLING OFFICE NAME AND ADDRESS

TECHNICAL SUPPORT DIRECTORATE
U.S. ARMY ELECTRONICS RESEARCH & DEVELOPMENT CMD
FORT MONMOUTH, NEW JERSEY

12. REPORT DATE

11 Jan[redacted]79

13. NUMBER OF PAGES

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)

15. SECURITY CLASS. (of this report)

UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Armor
Panel
Polymeric
Radar Antenna Hardening

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

(See reverse side.)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

402 550

Block No. 20

ABSTRACT

A set of two each engineering panels of each specification thickness were fabricated this period. The fabrication procedure employed extensive preconditioning steps and a long stepwise molding cycle.

Major steps in the preconditioning cycle involved a high vacuum conditioning of the loose stack and a long drying cycle at 225°F with the stack compressed under vacuum pressure. The molding cycle employed a long stepwise temperature rise and fall and a twenty minute dwell at maximum temperature.

Resultant panels had extensive surface delaminations, surface discoloration areas and a general lack of translucency.

Subscale panels were fabricated using a revised molding procedure that eliminated the high vacuum preconditioning, lowered all precondition temperatures to 180°F or less and employed a molding cycle with rapid heatup and cool down and a short dwell time.

The subscale panels appeared generally improved. Surface discoloration was eliminated and surface delaminations almost eliminated. The remaining problems were subsurface voids or trapped air pockets.

A redesign of the caul plate to caul plate seal has been started. It is the purpose of this redesign to eliminate the mechanical clamping required with the present seals. This change may aid in the correction of the void/trapped air problem.

In addition, a panel trim fixture utilizing a high pressure local edge hold-down in conjunction with a high speed router operation was used successfully to trim the engineering panels.

SI ER-915

SIXTH QUARTERLY REPORT

MANUFACTURING METHODS AND TECHNOLOGY PROJECT TO ESTABLISH PRODUCTION TECHNIQUES TO MANUFACTURE RIGID ARMOR FOR RADAR ANTENNA HARDENING

REPORT PERIOD

1 SEPTEMBER 1978 TO 30 NOVEMBER 1978

TECHNICAL SUPPORT DIRECTORATE
UNITED STATES ARMY ELECTRONICS
RESEARCH AND DEVELOPMENT COMMAND
FORT MONMOUTH, NEW JERSEY

PREPARED UNDER CONTRACT NO. DAAB07-77-C-0476

PREPARED BY

SWEDLOW, INC.

12122 Western Avenue, Garden Grove, California 92645

ABSTRACT

A set of two each engineering panels of each specification thickness were fabricated this period. The fabrication procedure employed extensive preconditioning steps and a long stepwise molding cycle.

Major steps in the preconditioning cycle involved a high vacuum conditioning of the loose stack and a long drying cycle at 225°F with the stack compressed under vacuum pressure. The molding cycle employed a long stepwise temperature rise and fall and a twenty minute dwell at maximum temperature.

Resultant panels had extensive surface delaminations, surface discoloration areas and a general lack of translucency.

Subscale panels were fabricated using a revised molding procedure that eliminated the high vacuum preconditioning, lowered all precondition temperatures to 180°F or less and employed a molding cycle with rapid heatup and cool down and a short dwell time.

The subscale panels appeared generally improved. Surface discoloration was eliminated and surface delaminations almost eliminated. The remaining problems were subsurface voids or trapped air pockets.

A redesign of the caul plate to caul plate seal has been started. It is the purpose of this redesign to eliminate the mechanical clamping required with the present seals. This change may aid in the correction of the void/trapped air problem.

In addition, a panel trim fixture utilizing a high pressure local edge hold-down in conjunction with a high speed router operation was used successfully to trim the engineering panels.

CONTENTS

CONTENTS - Continued

FIGURES

1.0 PURPOSE

The purpose of this program is to establish production techniques and production capabilities for the manufacture of armor panels. The armor panels are intended for use with flat radar antenna to provide protection from munitions fragments.

The armor panels will be flat molded sheets of various sizes and edge finishes. The sheets will be molded from cross-plied assemblies of unidirectionally oriented, blown film made from a dielectric grade polypropylene. A protective over lay will be molded into the panel surfaces and camouflage will be incorporated in or onto a portion of the panels.

The program is divided into four tasks as described below:

Step 1 Engineering Samples

Two sets of two each panels will be produced in order to demonstrate the ballistic capabilities of the selected materials and processes.

Step 2 Confirmatory Samples

Ten sets of two each panels of various sizes, thicknesses, and camouflaging methods will be produced in order to demonstrate the total capabilities of the panels in regards to environmental stability, electronic transmission, and ballistic characteristics. In addition, camouflaging techniques and panel trim and edge fusing will be demonstrated.

Step 3 Pilot Run

Thirty-two sets of two each panels will be produced in order to demonstrate the capacity of each production step and verify the capability of the line to fabricate at an acceptable rate.

Step 4 Production Capability Demonstration

An in-plant demonstration will be held in order to show the production capabilities of the pilot production line to invited representatives of industry and government.

The first, quarterly report described in detail the program objectives, tasks, and schedule.

2.0 INTRODUCTION

The following report covers the period from September 1, 1978 through November 31, 1978.

During this period, a manufacturing procedure was defined and two each 3/8" and 1" thick full scale engineering panels were fabricated using this procedure. The fabricated panels all had surface and subsurface defects. The most prominent defect was surface delamination, but whitish opaque areas and subsurface voids were also prevalent.

A meeting with Swedlow and government technical personnel was held during the third month of this period. The engineering panels that had been produced were examined and the procedures used to produce these panels were discussed. Several processing steps were indicated as possible contributers to the panel defects.

Using a revised fabrication procedure which modified or eliminated the steps that were in question, three subscale (3/8" x 12" x 12") panels were produced. These panels were improved in appearance with good translucency and minimal surface delaminations.

In addition, a router trim jig with a high pressure hold down was designed, fabricated, and successfully used to trim both 3/8" and 1" thick panels.

3.0 ENGINEERING SAMPLES

3.1 General

During this period, two of each size engineering samples were fabricated. The panel target thicknesses were 0.375 ± .015 incnes and 1.045 ± .015 inches respectively. Final trim size was 28 ± 1/32 inch x 38 ± 1/32 inch.

The process involves the lamination of polypropylene film that has been unidirectionally oriented to a 12:1 draw ratio and mandrel cross-plied to form loose pads. These pads are then sheared to molding size and preconditioned to remove moisture and air.

Lamination is accomplished by subjecting the thermoplastic film stack to a heat and pressure cycle to accomplish ply fusion and then cooling the laminate while still under pressure.

3.2 Fabrication Procedure

Based on previous process development work, a fabrication procedure was defined. This procedure incorporates a series of lengthy prelamination and lamination steps intended to provide a conservative process for engineering sample fabrication. Figure 1 (Flow Diagram, Engineering Sample Fabrication) shows a flow diagram of the steps used in the fabrication of the engineering samples. Note that a review of the processing steps and examination of the resulting panels indicated that revisions of several of the processing steps would be beneficial. These revisions are also noted in Figure 1 (Flow Diagram, Engineering Sample Fabrication). Figure 2 (Molding Assembly, 3/8 inches Panels) and Figure 3 (Molding Assembly, 1-inch Panels) show a sectional blowup of the two molding assemblies.

3.3 Fabrication Results

As noted previously, the engineering samples prepared during this period had extensive visual defects.

The major defects were concentrated at the panel surfaces either at the interace of the protective plies and the first cross-plies or within the adjacent cross-plies.

The surface defects included both delaminations and whitish discoloration. In addition, the general surface appearance was somewhat opaque and some areas with whitish striations were present on all panels.

Removal of the outer plies improved the panel translucence and eliminated all major delaminations. The remaining subsurface defects were small voids or trapped air pockets and minor delaminations.

The following is a summary of the resulting panel molded thicknesses:

Panel Serial Number	Target Thickness (inches)	Minimum Thickness (inches)	Maximum Thickness (inches)	Average Thickness (inches)	Variation from Target Thickness (inches)
100278-1	0.375±.015	0.364	0.385	0.375	0.375 +.010 -.011
100378-1	0.375±.015	0.359	0.381	0.371	0.375 +.006 -.016
100378-2	1.045±.015	1.071	1.109	1.093	1.045 +.064 - 000
100478-1	1.045±.015	1.022	1.051	1.036	1.045 +.006 -.023

ENGINEERING SAMPLE FABRICATION PROCEDURE	PROCESS REVISIONS SUGGESTED AT PROGRAM REVIEW
REMOVE CROSS-PLIED PAD FROM CONTAINER	
STRIP OFF PROTECTIVE FILM AND THREE TO FIVE ADDITIONAL PLIES	Discard any cross-plied material that has waves or wrinkles likely to form overlap in the laminate panel.
COMBINE PADS TO PREDETERMINED WEIGHT AND RECORD LOOSE THICKNESS	
ADD FOUR PLY OF PROTECTIVE FILM TO BOTH FACES	Reduce protective film from 4 plies to 2 plies per face and cut film back 1/2" from edge of cross-plied pad all around.
POWER PAPER SHEAR ASSEMBLY TO MOLDING SIZE	
ASSEMBLE FOR MOLDING WITH ALUMINUM FOIL AND NYLON FABRIC	Eliminate aluminum foil separator
POSITION SEAL FRAMES, FOAMED ALUMINUM SPACERS, AND INSERT MONITORING THERMOCOUPLES	Enlarge all vacuums passages to maximum practical diameter in order to facilitate evacuation.
CHECK VACUUM SEAL	Once vacuum is pulled, vacuum to be unbroken until molding is complete.
EVACUATE LOOSE STACK IN HIGH VACUUM CHAMBER TO 10^{-4} TORR	Discontinue this step.
MECHANICALLY CLAMP CAUL PLATES UNTIL VACUUM SEAL IS EFFECTED	Redesign the caul plate to caul plate seal so that the seal is effected on the loose stack without the use of mechanical clamping.
EVACUATE STACK AND OVEN DRY AT 225 ± 5°F AT 20-25 INCHES Hg FOR 15 HOURS MINIMUM	Limit oven temperature to 180°F maximum. Increase vacuum to 29 in. Hg minimum.
COMPRESSION MOLD ASSEMBLE AS FOLLOWS:	
1) LOAD INTO 225°F PREHEATED PRESS	Limit press preheat to 180°F maximum.
2) APPLY 2200 PSI PRESSURE	
3) RAISE CAUL PLATE TEMPERATURE STEPWISE TO 355°F	Raise caul plates temperature rapidly to 340°F and then more slowly to 355°F.
4) DWELL AT A MID-STACK TEMPERATURE OF 350°F -353°F FOR 20 MINUTES	Discontinue dwell and start cool down as soon as mid-stack reaches 350°F.
5) DECREASE TEMPERATURE STEPWISE TO ROOM TEMP.	Cool down rapidly to 300°F and then more slowly concentrating on minimizing face to face temperature differences.
REMOVE, INSPECT, AND TRIM	

FIGURE 1 FLOW DIAGRAM, ENGINEERING SAMPLE FABRICATION

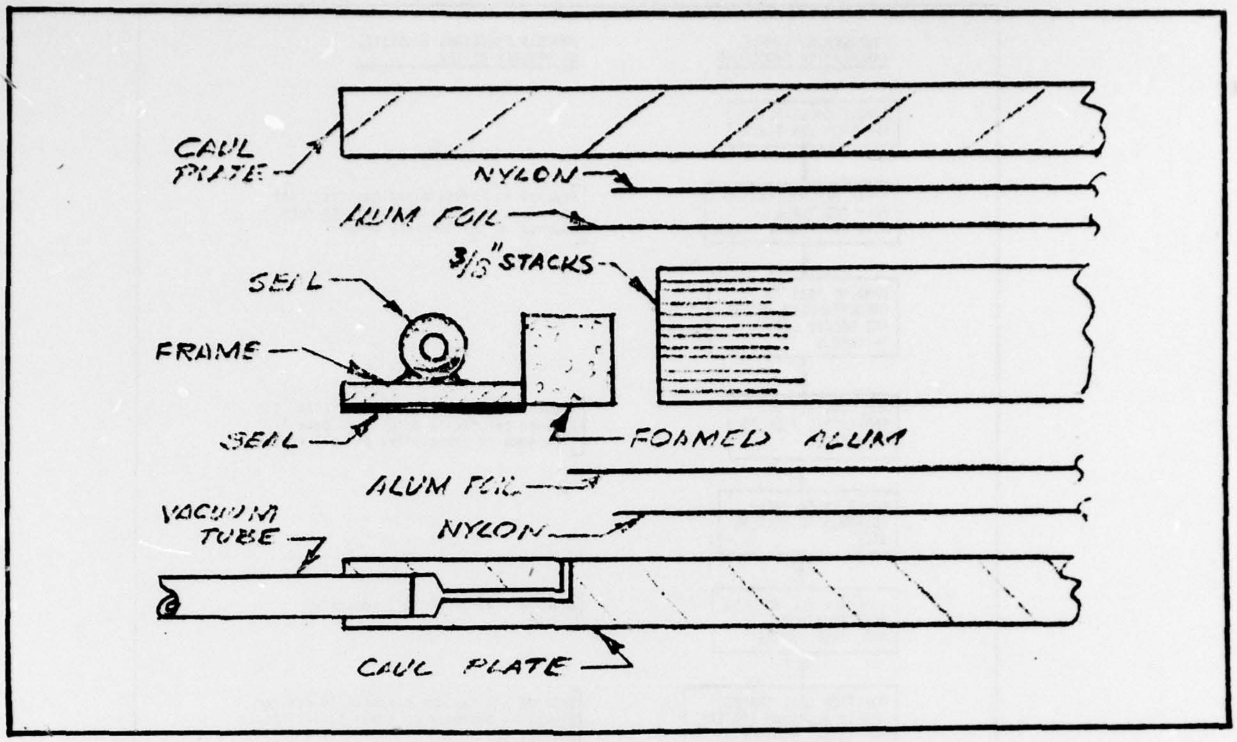
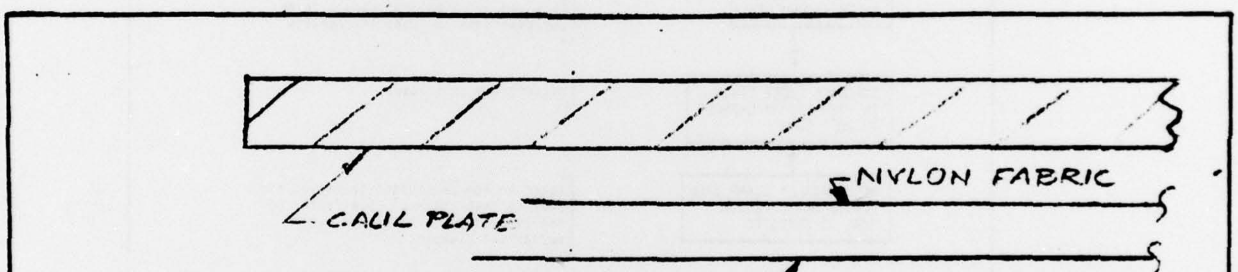


FIGURE 2 MOLDING ASSEMBLY, 3/8 INCH PANELS



FIRURE 3 MOLDING ASSEMBLY, 1 INCH PANELS

4.0 FABRICATION DEMONSTRATION AND PROGRAM REVIEW

A fabrication demonstration and program review was held November 1 and November 2 at Swedlow. During this meeting Swedlow personnel demonstrated procedures used to fabricate engineering samples to AMMRC personnel and presented the panels molded by these procedures. During these demonstrations and ensuing discussions the following procedural changes were suggested.

1. Revise the caul plate to caul plate seal design. Using silicone rubber sponge, design a seal with sufficient height or reach so that a vacuum seal can be made on the loose stack without the aid of mechanical compression of the assembly.

   If feasible, design stops to restrict the compression of the loose pad during evacuation and heat conditioning. The stops would be removed prior to molding.

   Reason: Prevent pressure caused seal-off within the loose stack and facilitate air and moisture removal.

2. Omit aluminum foil separators.

   Reason: Foil separators believed to serve no useful function.

3. Reduce the number of protective film plies (biaxially oriented polypropylene film) to two plies on each face. Solvent clean all protective plies and cut the plies at least one half inch inside the cross-plied pad edges.

   Reason: Avoid premature sealing of the top edge and subsequent air entrapment.

4. Enlarge all vacuum passages to maximum possible diameter.

   Reason: Facilitate rapid evacuation.

5. Inspect all cross-plied pads after trimming and discard any material that has excessive wrinkles or S shaped wrinkles that are likely to form overlaps or molded in wrinkles during final lamination.

   Reason: Eliminate any panel defects due to cross-ply pad wrinkles.

6. Limit the oven drying cycle temperature and the mold preheat temperature to 180°F maximum.

   Reason: Eliminate the possibility of orientation release of the film prior to application of containing pressure.

7. Revise the press curing cycle as follows:

   Rapidly heat the caul plates to 340°F and then more slowly to 355°F.

   Maintain 355°F platen temperature until the mid stack temperature reaches 350°F.

   At the mid stack temperature of 350°F, start rapid, forced cool down to 300°F.

   At 300°F, decrease the cool down rate and concentrate on minimizing face to face temperature differences.

   Reason: Increase heat up and cool down rates and eliminate dwell time in order to minimize film exposure at high temperature.

Three subscale panels were fabricated as described in the next section to evaluate the effectiveness of the above suggested changes.

5.0 SUBSCALE TEST PANELS

5.1 General

In order to evaluate the above procedural changes and also to determine if various components may be contributing to laminating problems, three 3/8" X 12" X 12" panels were fabricated.

The procedures used incorporated the process changes discussed in Section 4 with the exception of the revised seal design. These seals are presently being designed and will be fabricated and tested next period. The subscale panels were evacuated using a conventional vacuum bagging technique.

5.2 Fabrication Procedure

In order to determine if certain components might be contributing to fabrication problems, the panel components were varied as follows:

1. The cross-plied film was molded between aluminum caul plates without aluminum foil, nylon cloth, or protective face film.

   The film stack was contained between two 3/8" thick caul plates using rolled fiberglass edge spacer/venters. The assembly was evacuated using conventional vacuum bag techniques.

2. Same as 1 above except foamed aluminum spacer/venters were used instead of rolled fiberglass.

3. Same as 2 above except two protective cover plies of EK500 were used on each face. Plies were set back 1/2 inch from the edge of the cross-plied pad.

Figure 4 (Flow Diagram, Subscale Test Panels) shows a flow diagram of the steps used in the fabrication of the subscale test panels.

5.3 Results and Conclusions

The test panels showed marked improvement in general appearance and surface lamination as compared to the engineering sample panels. All panels were translucent and without the whitish areas prevalent in the previous panels. Surface delamination problems were also greatly reduced. Small areas on the first panel had surface delaminations. The second and third panels were almost without any surface defects.

The remaining problems involved subsurface voids and white, 45°, striations at the mid panel. The striations appear to be high pressure areas caused by a stackup of film edge overlaps. The trapped air generally occurs adjacent to or at the termination of these striated areas.

The subscale panel results show a significant improvement as compared to the results achieved during fabrication of the engineering panels.

It is probable that the improvement in general appearance or increased translucence can be attributed to the revised, more rapid cure cycle and that the minimization of surface defects are a result of the decreased preconditioning temperature from $225^{\circ}F$ to $180^{\circ}F$.

Of the various materials successively added to the molding assembly in order to check possible adverse effects, none appeared to be an adverse contributor during this testing.

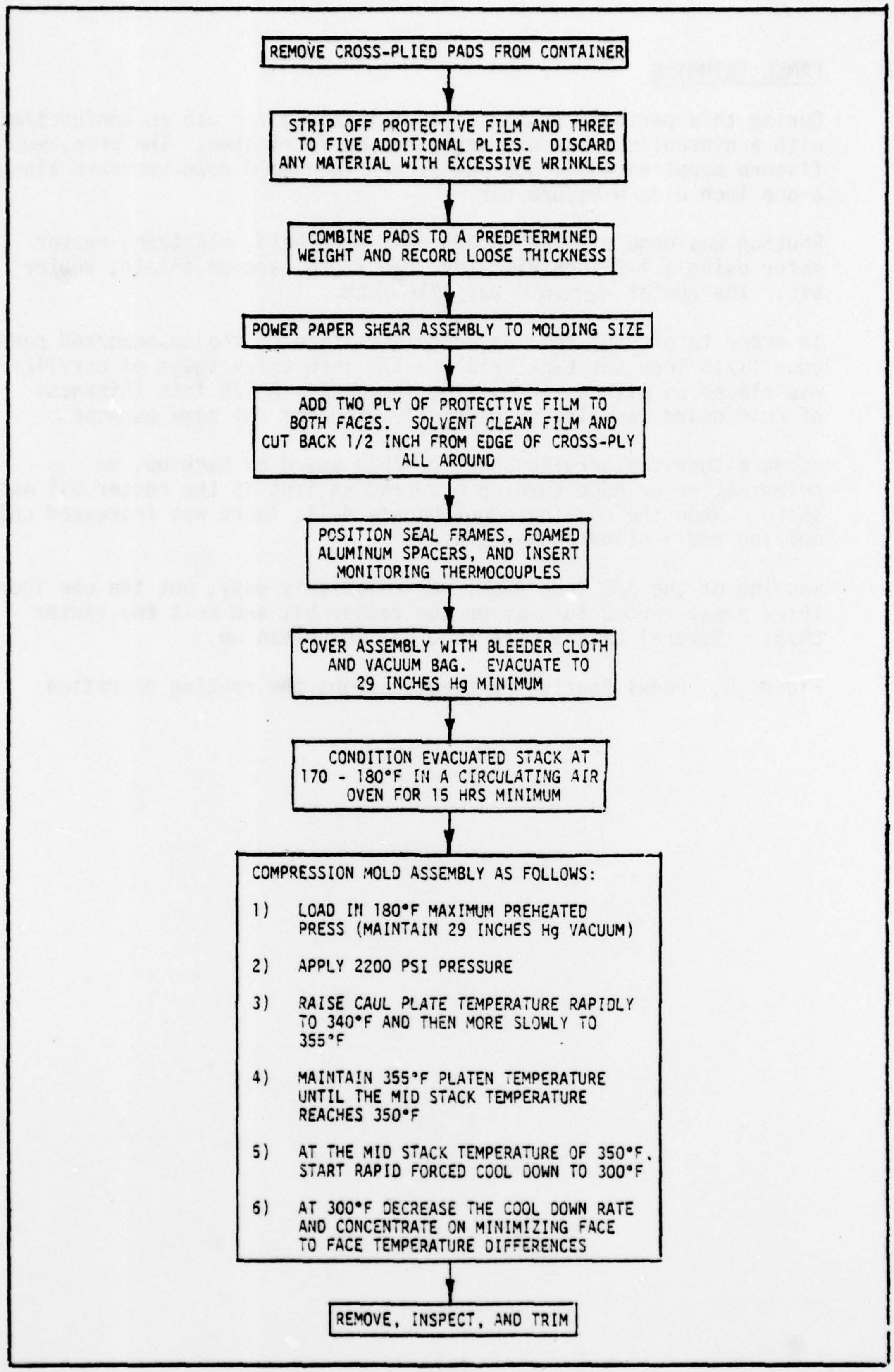


FIGURE 4 FLOW DIAGRAM, SUBSCALE TEST PANELS

6.0 PANEL TRIMMING

During this period a router fixture intended for use in conjunction with a hydraulic press was designed and fabricated. The press mounted fixture supplied 400 - 500 pounds per inch hold down pressure along a one inch wide pressure bar.

Routing was done with an 18,000 RPM, hand held, electric, router motor using a 1/2 inch diameter, two flute carbide inlaid, router bit. The router setback was 1/16 inch.

In order to prevent fold up or delamination of the unsupported panel edge (1/16 inch set back area), a 1/8 inch thick sheet of acrylic was placed on either side of the laminate. A 1/8 inch thickness of chip board was also successfully used for the same purpose.

Using either the acrylic sheet or chip board as back up, no delamination or edge turn-up occurred as long as the router bit was sharp. When the cutting edges became dull, there was increased chip melting and a slight edge turn-up.

Routing of the 3/8 inch panel was relatively easy, but the one inch thick panel tended to heat up the router bit and melt the router chips. Several passes were required for clean up.

Figure 5, "Panel Routing Procedure" shows the routing operation.

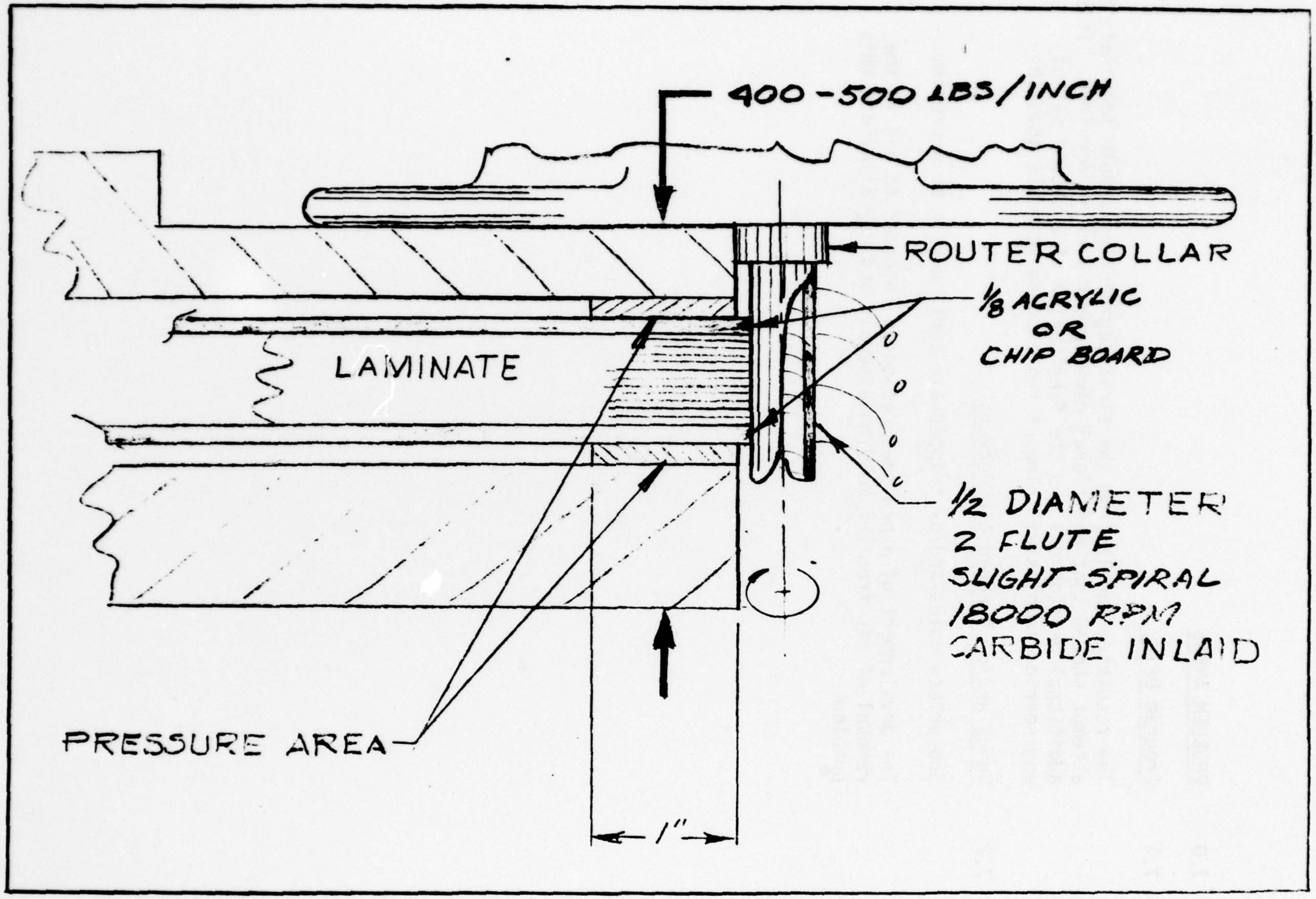


FIGURE 5 PANEL ROUTING PROCEDURE

7.0 PROBLEM AREAS

7.1 Program Delay

The resulting panels from the first engineering sample fabrication attempt showed that additional development work is required. This additional development and the fabrication of a second set of engineering samples will impact the program schedule adversely.

7.2 Voids and/or Trapped Air Pockets

Subsurface voids and/or trapped air continues to be a problem.

The development of a new seal design is intended to aid in the removal of air from the molding assembly and may alleviate this problem.

8.0 PROGRAM FOR NEXT PERIOD

8.1 Subscale Seals

Design and fabricate subscale seals in order to develop a seal design that will function efficiently both during deairation and moisture removal and during the molding cycles.

Fabricate panels using the above seals to evaluate the seal design and its effectiveness.

8.2 Full Scale Seals

Using the information developed above design and fabricate full scale seals in preparation for fabrication of a second set of engineering panels.

8.3 Second Engineering Sample Set

Fabricate and test a set of engineering sample panels using the above seals and other process changes that may be necessary.